

## NEW POLYCLADS FROM MONTEREY BAY, CALIFORNIA.

BY HAROLD HEATH AND ERNEST A. MCGREGOR.

The material serving as a basis for the present paper was collected along the rocky beaches on the southern border of Monterey Bay or was dredged in the shallow water off shore. That it does not embrace all of the polyclads inhabiting this region is recognized, but it probably includes the more common species, and will, it is hoped, stimulate others to complete the list and extend their investigations into other localities bordering the western coast of North America. It is a surprising fact that up to the present time, so far as we can learn, but three species of these animals have been recorded between Panama and the coast of Asia, a distance of over 7,000 miles. Stimpson's characteristically brief diagnosis of *Leptoplana maculosa* is far from being exclusive, and accordingly must exist as a *nomen nudum*. On the other hand, Miss Plehn's description of *Leptoplana californica* and *Amblycereus luteus* is accurate and complete, as we know from specimens in hand.

Concerning the habits of these animals, we have unfortunately little to say on the subject. In captivity practically all of the species fail to thrive, and if they live at all withdraw into some shaded nook or remain quiet for hours together. In their native haunts they are even more retiring, and observations upon their mode of life are very difficult. *Planocera californica* occupies sites farthest removed from low-tide mark. Under stones or in crevices of the rocks it finds a hiding place and a food supply consisting of small animals together with scant quantities of diatoms. Throughout the greater part of the year its egg masses, forming more or less circular patches from two to six millimeters in diameter, appear like encrusting plant growths concealed in crevices of the rocks or attached to the under surfaces of boulders scattered on the beach. About mean-tide mark and even higher on the shore where the surf breaks strongly, and from such situations down to the low-tide mark, nearly all of the species of *Leptoplana* find a home. *Leptoplana rupicola* was encountered upon two occasions only attached to the under surface of large rocks at about the limit of extreme low tide. This is likewise the habitat of *Leptoplana timida* and *Stylostomum*

*californicum*. Nothing further is known concerning their mode of life. *Leptoplana iniquita* was dredged on one occasion in water about six fathoms in depth; it is usually concealed in the burrows of rock boring mollusks (*Penitella penita*), and when dislodged proves to be an active, restless species incapable of living in captivity. *Leptoplana saxicola* is peculiar in that it inhabits small, elevated tide pools whose waters are changed only during rough weather, when they are submerged in the dashing surf. A growth of algæ (*Cladophora*) frequently lines such pools, and in its feltwork this species may be found in abundance, living upon small mollusks, crustacea, and an occasional rhabdocele, whose remains have been found in the digestive tract. The species of *Eurylepta* and *Amblycercus* are usually found in the rhizoids of the brown kelp (*Macrocystis pyrifera*). *Amblycercus luteus* is an active swimmer, progressing by means of wave-like undulations of the margins of the body. Most of the remaining species described in the following pages were secured from collections made by students attending the seaside laboratory of Stanford University at Pacific Grove and were gathered at low tide, though we have no accurate information concerning their exact habitat or mode of life.

The food of several of the species consists largely of minute organisms in the plankton or small, strictly littoral species. In their digestive tracts have been found small spores, unicellular plants, especially diatoms, numerous sponge spicules, remains of amphipods and isopods, multitudes of *Sabella* larvæ, small annelids and the radulæ of gastropod mollusks. These substances frequently impart a characteristic color to the animal, and several of the more transparent species derive much of their apparent outward tint to materials in the digestive tract, as is shown by keeping such animals in captivity without food until that already eaten has digested, when their true color becomes apparent.

In the fixation of these animals the ordinary methods were employed. Lang's formula particularly was used with good results, but was slightly inferior to another solution that we devised during the course of our study. To 4 parts of a saturated solution of corrosive sublimate 1 part of formaldehyde was added, and 100 parts of this mixture were combined with 5 parts of glacial acetic acid. The solution was used hot and usually was poured over the specimen, though active, highly contractile individuals were often imprisoned between two microscope slides lightly held together. When this last-named device was employed, the specimen usually remained attached

to one of the slides, and in this position was passed through the various grades of alcohol and cleared and mounted. In a few species the active movements of the body may be inhibited to a considerable degree by allowing them to remain for some time in sea water held in small vessels, but in the greater number of cases the resulting sluggishness is accompanied by an abnormal distortion of the body that is difficult to overcome. Chloretone (aceto-chloroform) and a number of other narcotizing agents were used from time to time, but without much success, since the animals, even while comparatively active, would undergo a surprising degree of disassociation of the tissues. Delafield's hæmatoxylin was usually employed as a stain, occasionally with Orange G or rubin, and after such treatment the specimens were generally examined in clove oil and finally mounted in balsam.

#### KEY TO CALIFORNIA SPECIES.

- I. Without sucking disc on ventral surface.....Tribe ACOTYLEA.
  - A. Nuchal tentacles present.....Family PLANOCERIDÆ.
    - a. Pharynx almost wholly in middle half of body; antrum-masculinum continued close to dorsal surface as a crescent-shaped blind sac; accessory sac 3-parted,
      - Planocera californica.*
    - aa. Pharynx nearly central; antrum-masculinum normal; accessory sac normal.
      - b. Nuchal tentacles at beginning of second fourth of body; ample pharynx with large deep folds; sex openings rather close to posterior border of pharyngeal pocket.....*Planocera burchami.*
      - bb. Nuchal tentacles before end of first fifth of body; pharynx small and weakly folded; gut branches anastomosing; sex openings far removed from pharyngeal pocket and from posterior end of body,
        - Stylochoplana californica.*
  - AA. Nuchal tentacles wanting.....Family LEPTOPLANIDÆ.
    - a. A single seminal vesicle.....Genus LEPTOPLANA.
      - b. Separate sex openings.
        - c. Vasa deferentia anastomosing.....*L. rupicola.*
        - cc. Vasa deferentia unbranched; gut branches anastomosing.
          - d. Pharynx central, deeply lobed; penis broad, blunt; accessory sac lying wholly behind the female opening.....*L. timida.*
          - dd. Pharynx considerably nearer the posterior end, weakly folded; penis very long, attenuate; accessory sac lying wholly before the female opening.....*L. saxicola.*

- bb. Common sex opening.
  - c. Tentacle eyes small, numerous; cerebral eyes minute, converging anteriorly.....*L. californica*.
  - cc. Tentacle eyes large, few; cerebral eyes not converging.....*L. inquieta*.
  - aa. A pair of seminal vesicles.....*Phylloplana litoricola*.
- II. With sucking disc on ventral surface.....Tribe COTYLEA.
  - A. Numerous gut branches; tentacles appear as marginal folds; pharynx folded.....Family PSEUDOCERIDÆ.
    - a. Approximately 50 pairs of gut branches,  
*Lichenoplana lepida*.
    - AA. Few gut branches; solid marginal tentacles; pharynx without folds.....Family EURYLEPTIDÆ.
      - a. Mouth and male sex opening a common aperture; female pore before hind end of pharynx,  
*Stylostomum californicum*.
      - aa. Mouth and male aperture not united; female opening behind posterior end of pharynx.
        - b. Mouth immediately behind the brain which is close to the anterior body margin; male aperture under front end of pharyngeal pocket; tentacles lacking,  
*Aceros langi*.
        - bb. Mouth well removed from brain and body margin; male aperture behind pharyngeal pocket or ventral to posterior end of it; tentacles usually present.
        - c. Eyes lacking in region of tentacles; vasa deferentia and uteri anastomosed; no uterus glands,  
*Anciliplana graffi*.
        - cc. Eyes present in tentacle region.
          - d. A pair of uterus glands present; gut branches and vasa deferentia not anastomosing,  
*Eurylepta aurantiaca*.
          - dd. Uterus glands wanting; gut branches anastomosed.....Genus EURYLEPTODES.
          - e. Granular gland present; vasa deferentia unbranched.
            - f. Tentacles well developed.....*E. cavicola*.
            - ff. Tentacles absent or rudimentary,<sup>1</sup>  
*E. pannulus*.
          - ee. Granular gland absent; vasa deferentia elaborately anastomosed.....*E. phyllulus*.

### Tribus ACOTYLEA.

Without sucking disc. Mouth in middle of the body or behind it. Pharynx ruff-like. Copulatory apparatus in the posterior end of the body. Without tentacles or with nuchal tentacles.

<sup>1</sup> Cf. page 485.



Family **PLANOCERIDÆ** Lang, 1884.

With nuchal tentacles. Mouth about the middle of the body. Penis directed backward.

Genus **PLANOCERA** de Blainville, 1828.

With slender, pointed nuchal tentacles well removed from the anterior end of the body. Separated sex openings a considerable distance from the posterior end. Eyes on bases of tentacles and in the brain area.

**Planocera californica** sp. nov.

This species is fairly abundant along the southern coast of Monterey Bay, and to the south for at least thirty-four miles. It usually occurs above mean tide in crevices of the rocks and beneath boulders on the beach. The ground color is light transparent olive, upon which a system of chocolate-colored markings occur, corresponding closely to the position of the digestive tract. A long bar of this color extends along the mid-dorsal line from the front of the brain to the reproductive openings, sending off lateral branches along its course which ramify to the body margin. On the ventral surface of the animal the tissues are unpigmented and the somatic muscles are of whitish cast and so opaque that the internal organs are invisible.

The largest specimen (Pl. XVIII, fig. 39) measured 24 mm. in length by 14 mm. in width, and the oval or broadly elliptical body is of very firm consistency. Nipple-like retractile tentacles occur immediately before the end of the first fifth of the body. The eyes (text fig. 1) occur in the two usual groups—one, consisting of about ninety large ocelli in each of the tentacle clusters distributed in and about the tentacles in somewhat spindle-shaped areas diverging anteriorly, while the other, the cerebral set, comprises about sixty-five smaller eyes, commencing at the level of the posterior border of



Fig. 1.—Eyes of *Planocera californica*.

the brain and extending directly forward along the sides of this organ to a point a little farther from the brain than its length.

The mouth (Pl. XVIII, fig. 39), situated somewhat in front of the middle of the body, opens into the pharynx, which is placed almost entirely in front of the centre of the animal. Its length is between one-third and one-fourth that of the body, and is devoid of diverticula although it is moderately folded. The rather narrow main gut, of about the same length as the pharyngeal pocket, bears six or seven pairs of lateral branches with occasional alternating out-pouchings. A median branch crosses the brain, and it like the others is without anastomoses.

It is evident that this species is carnivorous, as both the type and cotype contain radulae of some gastropod mollusk. In one individual a radula occupies the anterior branch of the gut, extending across the brain, and shows signs of disintegration under the action of the digestive juice. Also in many of the gut pouches isolated teeth are to be seen in considerable numbers.

The brain is situated at the beginning of the second sixth of the body length, and is unusually clearly bilobed. The accompanying groups of granules (Körnerhaufen) are clearly evident, but the nerves, even in sections, are very indistinct, and accordingly no attempt has been made to determine their distribution.

The testes are ventrally distributed, but are not clearly united with the sperm capillaries, nor have these last-named canals been seen to unite with the vasa deferentia. Each vas deferens appears to originate at about the level of the male aperture, from which point each pursues its course directly forward as a convoluted, unbranched duct until abreast of the posterior end of the pharyngeal pocket where it bends suddenly inward and backward, finally opening beside its fellow into the small seminal vesicle (Pl. XV, fig. 24) located immediately posterior to the pharynx. The posterior contracted end of the seminal vesicle is continuous with the immense, spindle-shaped, granular gland whose walls are more or less continuous with the tissue of the penis. The slender penis is of an unusual type in that it is curved upward (Pl. XVI, fig. 32) and opens into a large cup-shaped cavity that is a dorsal continuation of the antrum masculinum. Several chitin-like spurs project into this space from its anterior wall. Ventrally the antrum is modified to form a long, slender passage, which opens to the exterior ventral to the above-described cavity.

The ovaries are in large measure dorsal, and in a few locations

have been seen to connect with what appears to be an anastomosing series of canals. The uteri are very distinct in the cotype, and are united anteriorly immediately in front of the pharynx. Relatively small ova occur throughout their entire length, save in the immediate neighborhood of the median egg canal. This last-named tube (Pl. XV, fig. 24) is continued posteriorly, and opens into the central region of the accessory sac, which in this species consists of three large pouches of equal size, the usual median one and an anterior pair bordering the egg canal. Anteriorly, the egg canal expands into the ample bursa, abundantly supplied with glands, that opens to the exterior not far behind the male aperture.

*Planocera burchami* sp. nov.

This species is represented by five individuals collected in Monterey Bay at a depth of ten fathoms. The color in alcohol was at first a brownish-pink over the pharyngeal area, with a dark brown line along the middle of the dorsal surface marking the position of the main gut. From the pharyngeal area outward, the color gradually changes to a creamy-pink in the neighborhood of the body margin. The entire dorsal surface is blotched with white pigment in varying quantity, though the spots are generally of small size. A small non-pigmented area between the tentacles marks the position of the brain. The ventral surface of the animal is unpigmented, and through the somatic musculature the brain, pharynx, uteri and vasa deferentia are clearly visible.

All of the specimens are broadly oval in outline, and the largest measured 14 by 11 mm. The mouth (Pl. XV, fig. 27) is placed very nearly in the centre of the ventral surface. The tentacles and brain are situated one-fourth of the body length from the anterior margin, the former appearing in preserved material as small, blunt, and hemispherical projections. Circular groups of eyes (Pl. XIII, fig. 9) are ranged about their bases, and numerous ocelli are also scattered irregularly between the tentacles. No eyes occur on the body margin.

The external mouth leads into the pharyngeal pocket that with broad, ample lateral divisions extends at least two-fifths of the body length. The main intestine, closely coinciding with the pharynx in outline, gives rise to six or seven pairs of stout lateral branches and an anterior offshoot, which immediately forms three subdivisions posterior to the brain. The ultimate divisions of the intestine have never been seen to anastomose.

The brain, about one-fourth the length of the body from the anterior end of the animal, is oblong in transverse diameter, slightly emarginate in front and behind, and gives rise to at least four pairs of lateral nerve trunks. Over most of the body the larger nerve trunks have been traced with unusual distinctness, and the results show that the nervous system in general conforms to the usual type.

The testes are ventral, and especially in an immature state their arrangement suggests that they are united by sperm canals, forming an anastomosing system, though, generally speaking, these capillaries are invisible. The vasa deferentia, on each side of the body, form a narrow, inverted-U-shaped loop whose distal end arises abreast of the male aperture, the bend occurring opposite the mouth. Owing to the rather poor preservation of the specimens, the details of the male reproductive apparatus could not be determined completely. The proximal ends of the vasa deferentia appear to terminate in what seems to be a large antrum masculinum (Pl. XVIII, fig. 44), but no seminal vesicle could be seen nor could the penis be clearly studied, although it is doubtless directed backward. The male sex opening is well removed from the pharyngeal pocket.

The ovaries are dorsal, and an anastomosing connecting system of oviducts exists. The uteri extend forward, running parallel to the inner limbs of the vasa deferentia, and thus pursue a course directly forward to the tentacles to terminate immediately behind them. Posteriorly, these canals pass dorsal to the vasa deferentia, and lateral to the male aperture where they bend quickly inward toward the median line. As in the case of the male reproductive system, the details of the female reproductive complex could not be ascertained with certainty. The uteri appear to lead directly into a large antrum femininum, but there are also indications of an accessory gland, though its relations were not established satisfactorily. The female sex opening is immediately behind that of the male system.

Two peculiar deep pits (Pl. XVIII, fig. 44, *dp*), one immediately in front of the level of the male aperture and one immediately behind the female aperture, occur on the dorsal surface connected by a narrow, shallow groove. This appears in two of the largest individuals, but there is no clue to their function.

Named in memory of Mr. Samuel Burcham, who undertook the investigation of the polyclads of the California coast while a student at Stanford University. This work, still in its early stages, was terminated by his untimely death.

Genus **STYLOCHOPLANA** Stimpson, 1857.

Stubby tentacles about one-fifth the body length from the anterior end. Male and female genital pore united and well removed from posterior end of body. Eyes on basis of tentacles and in brain area.

***Stylochopiana gracilis* sp. nov.**

This very small species is represented by eight individuals, all of which were taken on the broad thalli of *Macrocystis pyrifera*, growing in the vicinity of the wharf of the Del Monte Hotel, near Monterey. It was most often found on surfaces encrusted with colonies of bryozoa. The color of the dorsal surface is pale brownish-yellow or buff, fading gradually as the margins of the body are approached. The ventral surface is unpigmented, yet the tissues are so opaque that little more than the digestive tract is visible in living material.

The largest specimen measured 7.5 mm. in length by 3 mm. in width. In every case the outline of the body is cuneate-oval (Pl. XII, fig. 2) with a broad semi-truncate anterior margin, while the posterior end is usually pointed. The mouth is located slightly in front of the middle of the body. The penis is directed backward. Finger-like nuchal tentacles are placed at the end of the first body fifth. The eyes (Pl. XIV, fig. 20) are arranged in two groups. The tentacle pair, each consisting of about four medium-sized eyes, is confined to the basal portion of the tentacles, while the cerebral clusters, fairly well differentiated, comprise approximately fourteen eyes each.

The mouth (Pl. XII, fig. 2) opens into the pharynx, which is considerably nearer the anterior than the posterior end, and covers an extent equal to one-fourth the length of the animal. The pharynx is slightly folded only, though the resulting inconspicuous lobes are relatively numerous. The main gut is narrow, of moderate length, and possesses usually seven pairs of intestinal branches with alternating diverticula. The posterior pair terminate the gut immediately behind the pharyngeal pocket, but anteriorly a median branch continues forward across the brain. All of the branches immediately anastomose and continue to do so until close to the margin of the body.

The brain holds a position at the commencement of the second body sixth, but as the main nerve trunks to which it gives rise are typical and their ramifications are very difficult to follow, no serious attempt has been made to examine critically this particular system.

The testes, for the most part ventrally placed, have not been seen to connect with sperm capillaries, but the vasa deferentia, on the



other hand, are clearly defined, convoluted, unbranched canals continuous across the mid line immediately behind the female reproductive pore. From this point they swing forward, diverging gradually until opposite the posterior end of the pharynx where they bend abruptly, and parallelling the outer trunks for a relatively long distance pass inward and forward to the anterior end of the seminal vesicle. This last-named organ (Pl. XII, fig. 6) is of moderate size, muscular, oval in form, and is placed far behind the pharynx. Leaving it posteriorly the short ejaculatory duct immediately enters (Pl. XV, fig. 26) what is doubtless the granular gland. The latter is of an unusual type. It is round-oval in form and its walls, produced posteriorly, appear to be continuous with the tissue of the penis. The penis is short, blunt, and projects into an ample antrum masculinum.

Generally speaking, the ovaries are dorsal, but no connections have been traced between them and the uteri. These canals have their origin opposite a point midway between the mouth and the front end of the pharynx. From here they extend backward, closely skirting the pharynx, at whose posterior extremity they approach one another and close to the mid line continue their course, diverging slightly in order to pass around the male reproductive pore where they enter the common egg canal (Pl. XII, fig. 6). The latter is short, and almost at once extends forward and ventrally to open into the antrum femininum. Posteriorly, the egg canal is continuous with the moderate-sized accessory sac (Pl. XV, fig. 26). The female orifice is usually a short distance posterior to that of the male, though two specimens possess a common opening.

No histological examination was made of the reproductive system.

*Leptoplana rupicola* sp. nov.

This large species is represented by three individuals found adhering to the under surface of large rocks near extreme low-tide mark a short distance south of the entrance to Monterey Bay. The largest specimen, 35 mm. in length by 15 mm. in width, is somewhat oval in form (Pl. XII, fig. 3), having the anterior end more rounded than the posterior. The color above is light with a pinkish or reddish tinge very marked in one of the specimens. There is a dark brown or brownish-red line along the mid line in the region of the pharynx. At the margins of the body the color is usually very faint. Ventrally, pigment is absent and the reproductive system and the pharynx appear with considerable distinctness. A clear,



translucent spot marks the position of the brain. The mouth is situated almost exactly in the centre of the body. Tentacles are lacking. The penis is placed about one-third of the distance from the mouth to the posterior end, well behind the pharyngeal pocket, and is directed backward. The eyes (text fig. 2) are arranged in four groups, a comparatively long pair of approximately 30 eyes in each adjacent to the brain, and a small more rounded, laterally placed pair comprising about 30 eyes in each cluster. No eyes occur elsewhere in the body.



Fig. 2.—Eyes of *Leptoplana rupicola*.

The pharyngeal pocket, scarcely one-third the length of the body, is supplied with numerous irregularly lobed diverticula, corresponding in a general way to the folds of the pharynx. The main gut is of about the same length as the pharynx, though is much more slender in outline, and is provided with approximately fifteen pairs of lateral intestinal branches whose subdivisions give no signs of anastomosing.

The brain is placed very nearly one-fourth of the body length from the anterior margin of the body, and as described previously is associated with two pairs of eye clusters. The ventral system of nerves is fairly well defined and conforms to the usual type.

The testes are ventral, and what appears in sections to be an anastomosing system of sperm canals unites them with the vasa deferentia. The last-named tubes (Pl. XII, fig. 3) are continuous across the mid line immediately posterior to the female reproductive pore, and from this point extend forward, diverging somewhat, as they become increasingly anastomosed. Opposite a point slightly anterior to the level of the mouth this elaborate network bends upon itself, skirts the margin of the pharynx, and not far behind the posterior end of the gut each becomes reduced to a single duct which sweeps inward and forward to fuse with its fellow in the mid line. This median duct (Pl. XV, fig. 22) proceeds in an anterior direction for a short distance, then bends upon itself and immediately enters the small but muscular seminal vesicle. Emerging from this at the

opposite end, the canal plunges at once into the comparatively large granular gland (Pl. XIII, fig. 13), and after its exit pursues its course to the base of the penis. A triangular muscular sheath surrounds the seminal vesicle and the terminations of the vasa deferentia. The copulatory apparatus is single and of the normal type. A large antrum masculinum is present.

As usual, the ovaries are dorsal and the uteri anteriorly are continuous across the mid line (Pl. XII, fig. 3). Immediately posterior to the male reproductive opening the uteri bend inward and meet to form the median oviduct (Pl. XV, fig. 22) that exists in the form of a relatively large canal, on one hand uniting with the long yet ample accessory gland and in the other direction with the spacious shell gland chamber and the antrum femininum. The opening to the exterior is close to that of the male and immediately in front of the accessory gland.

*Leptoplana timida* sp. nov.

This species is evidently rare as it is represented by only two individuals taken along the southern shore of Monterey Bay. The color of the dorsal surface is clear, translucent white, dotted more or less uniformly with minute dark red spots. In the central regions of the body these pigment spots are closely grouped to form a transverse, saddle-shaped blotch that becomes especially conspicuous when the animal is in a contracted condition. On the ventral surface of the body pigment is lacking, and through the white, semi-transparent somatic muscles the pharynx and vasa deferentia may be distinctly seen in living specimens.

The body is broadly oval in shape (Pl. XII, fig. 1), blunt anteriorly, and the type specimen measures 23 mm. in length by 12 mm.



Fig. 3.—Eyes and brain of *Leptoplana timida*.

in breadth. The mouth is situated a very short distance posterior to the centre of the body. Tentacles are lacking. The penis is located immediately behind the pharyngeal pocket one-fourth of the length of the body from the posterior end and is directed backward. The eyes (text fig. 3) are arranged as usual in four clusters, the

cerebral consisting of about 40 in each on both sides of the brain, while the tentacle groups, each comprising 12 comparatively large irregular ocelli, are more laterally placed. No eyes occur on the margins of the body.

The pharyngeal sheath (Pl. XII, fig. 1) is of nearly half the body length and is provided with broad, irregularly lobed branches. Owing to the compression of the animal during its fixation, the main intestine cannot be clearly differentiated from the pharynx, but it apparently exists as an elongated organ extending the full length of the pharynx posteriorly and at least as far as the brain anteriorly. Approximately sixteen pairs of lateral branches have been distinguished which appear to finally anastomose, though of this we cannot be positive.

The brain is situated one-third of the distance from the mouth to the anterior end of the body, but neither it nor the nerves originating from it present any noteworthy features.

The testes are placed in the ventral half of the body, and although no anastomosing system of sperm canals could be distinguished, the position of the male reproductive glands suggests that one probably exists. The vasa deferentia (Pl. XII, fig. 1) present the form of a heart-shaped loop, since they are continuous across the mid line immediately behind the female aperture, from whence they extend anteriorly and laterally to arch inward ventral to the uteri opposite a point not far behind the mouth. They then bend backward and inward and, fusing, unite with the seminal vesicle (Pl. XIII, fig. 12), surrounded by an ellipsoid muscle sheath, situated immediately behind the posterior end of the pharynx. Emerging from this organ, the canal immediately pierces the spherical granular gland and enters the base of the penis. This last-named organ is unusually thick at its base in proportion to its length, and in the type specimen the opening to the exterior is opposite to its base.

The ovaries are dorsal and are connected with the uterus by an anastomosing system of capillaries. The uteri entirely surround the pharynx since they are continuous across the mid line anteriorly. Posterior to the penis, these canals swing inward and unite to form the single, median egg canal (Pl. XIII, fig. 12) that on one hand expands to form the spacious antrum femininum and in the other direction communicates with the accessory gland, a long, roomy sac extending well behind the female reproductive pore.

*Leptoplana saxicola* sp. nov.

This small flatworm is represented by numerous individuals taken at a point a few miles south of the entrance to Monterey Bay. It occurs usually in masses of algæ (*Cladophora*) in tide pools of such elevation that the water is renewed only during rough weather. Dorsally the ground color varies from yellowish to grayish-brown.

A light stripe generally occupies the area immediately above the main gut which may be bordered laterally by a brownish band. When this last-named variation occurs, light streaks free from pigment radiate from it to the margins of the body. A clear spot generally marks the position of the brain. On the ventral surface pigment is entirely lacking or is present in very slight amounts, so that the more important organs may be seen through the translucent body wall with considerable distinctness.

The largest specimen measured 11 mm. in length by 5 mm. in width, and is narrowly elliptical in outline (Pl. XII, fig. 4). The mouth is situated about one-third of the length of the body from the posterior end of the animal. The penis is directed backward. Both cerebral and tentacle eyes (Pl. XIV, fig. 19) occur associated with the brain; none exist on the margins of the body. The tentacle clusters form small groups lateral to the brain, each consisting of about ten medium-sized eyes. The cerebral groups are not sharply differentiated from the others, but in a general way they present a linear arrangement on either side of the mid line bordering the brain and anteriorly expand to form loose clusters in front of the brain. There are approximately 25 small eyes in each of these groups.

The most conspicuous feature of the digestive system is the posterior position of the pharynx (Pl. XII, fig. 4) and external mouth. The first-named organ is about two-fifths the length of the body and is provided with five or six folds of moderate size on each side. The inner mouth is some distance anterior to the true mouth. The main gut is long, rather narrow, and possesses six or seven pairs of lateral intestinal branches, with occasional alternating shorter diverticula, and an anterior and posterior outgrowth along the mid line. Anastomosing immediately commences, resulting in a highly complicated intestinal network. Varying quantities of diatoms and sponge spicules were generally present in the digestive tract.

In this species the nervous system appears with unusual distinctness and has accordingly received more than usual study. The ventral system (Pl. XIV, fig. 21) conforms closely to the type found to occur in polyclads generally, but in addition to this there is what appears to be an independent network extending over the entire dorsal surface of the body. It comprises three pairs of main branches, arising from the lateral and anterior surfaces of the brain, that after dividing repeatedly extend to the margins of the body. Along the mid line, in the region of the pharynx, these delicate fibres become

lost to sight owing to the opacity of the animal, but as they appear here and there in sections it is probable that the network spreads over the entire dorsal surface of the body. The average size of the component nerve bundles is less than those of the ventral side, and the meshwork is considerably more open; otherwise there are no especially noteworthy features not represented in the figures.

Heath ('07) has described a dorsal nervous system, conforming to the same general plan, in *Planocera hawaiiensis*, and it is known to exist in the trematodes (cf. Heath '02). Lang has theoretically related the ctenophores and the flatworms on the basis of several deep-seated resemblances, appearing especially in the course of the embryological development. In the ctenophores there is, as is well known, a nervous system fashioned on the quadriradial plan. In the chiton larva there are likewise indications that in the early stages the central nervous system is constructed upon essentially the same plan. In the chiton the dorsal limbs of the cross-shaped fundament disappear apparently without becoming functional, but it is possible, though by no means proven conclusively, that they persist in the polyclads and develop into the network of the dorsal side of the body.

The testes, ventral as usual, are united by delicate sperm capillaries with the convoluted but unbranched vasa deferentia (Pl. XII, fig. 4), which present the form of an inverted-U-shaped loop. The outer limb of each loop passes backward to fuse with its mate immediately behind the female reproductive pore. The inner trunk extends inward and backward and unites with its fellow in the mid line to form a short common duct (Pl. XVI, fig. 30), which at once enters the posterior end of the large, elliptical seminal vesicle situated close behind the pharynx. Leaving the seminal vesicle anteriorly, the sperm canal, functioning as a ductus ejaculatorius, turns directly backward and, piercing longitudinally the very large, oval granular gland, immediately enters the base of the penis. This last-named organ in this species is unusually long and attenuate, and is contained in a similarly slender sheathing chamber at whose apex the external pore is located.

The ovaries are dorsal and are united by tubes, very indistinct except during the egg-laying season, that in turn connect with the uteri. These last-mentioned canals meet across the mid line anteriorly (Pl. XII, fig. 4) not far from the posterior border of the brain and, arc-like, extend backward with occasional anastomoses in some individuals, if not in all. In some cases well-developed outpouchings of the uteri occur, especially in the region of the brain and at a point



about opposite the mouth. Proximally, the uteri converge immediately behind the male reproductive opening and enter the short, stout egg canal (Pl. XVI, fig. 30) that in turn communicates with a short yet spacious accessory sac situated in several instances anterior to the external opening. Posteriorly, the egg canal expands into the antrum femininum which communicates exteriorly by means of a pore very close to that of the male reproductive system. In a few individuals, young and old, there is a common reproductive opening.

Although this is a small species, the ova are the largest that have been observed by us. In one case measurements showed the diameter of an ovum to be one-seventh the width of the body, or more accurately stated, its diameter was 0.61 mm. About opposite the seminal vesicle, and within the loops of the vasa deferentia, there are to be seen a pair of small gland-like bodies (Pl. XVI, figs. 30, 85) whose connections have not been traced.

*Leptoplana californica* Plehn.

Broad oval. Length 12 mm., breadth 9 mm., broader in front than behind. Colorless in alcohol. Pharyngeal pocket central, in length equal to one-half that of the animal, with seven pairs of average-sized lateral diverticula, containing the sharply folded pharynx. Tentacle eye clusters small, elliptical, diverging anteriorly; cerebral groups longer and narrower, converging anteriorly, with a single large eye terminating each in front. Common sex opening near posterior end of body, leading on one hand into an ample bursa copulatrix and posteriorly into a large accessory chamber; uteri, surrounding the pharynx, lead to a well-developed antrum femininum; penis with a long, sharp and flexible stylet; a granular gland and seminal vesicle on direct line to union of vasa deferentia.

Type locality, Monterey Bay, Calif., at a depth of 30-40 meters. Two specimens in our collection agree with the foregoing description.

*Leptoplana inquieta* sp. nov.

Four species represent this species captured about the low-tide limit among the rocks, and in one case among the rhizoids of *Macrocystis* in Monterey Bay. It is a small, restless species, crawling rapidly when disturbed, but never swimming. Dorsally the color is clear, translucent white, dotted more or less uniformly with small dark red pigment spots. Ventrally it is unpigmented, and the pharynx and vasa deferentia show faintly through the body wall.

The largest specimen is broadly oval in form (Pl. XIII, fig. 8)



with the anterior end broadly rounded or even truncate, while the posterior extremity is narrowed. It measures 9 mm. in length by 5 mm. in width. The mouth is placed slightly behind the centre of the body. The penis is directed backward. Nuchal and marginal tentacles are wanting. Eyes occur in four distinct clusters (Pl. XVIII, fig. 43), the tentacle pair, each consisting of seven or eight large ocelli, and a pair of cerebral groups. The last-named comprise approximately thirty relatively small eyes in each set, forming an elongated patch bordering the brain. No eyes occur on the margins of the body.

The digestive system (Pl. XIII, fig. 8) presents no especially novel features. The external mouth leads into a considerably folded pharynx whose length is between one-third and one-half that of the body. Laterally it is produced into seven pairs of lateral diverticula. Directly dorsal to the outer mouth the opening from the pharynx leads into the mid-gut, which in turn possesses seven pairs of lateral intestinal branches together with an anterior offshoot leading forward across the brain. This system ramifies chiefly by means of simple branching, but occasional anastomoses were seen, especially in the neighborhood of the pharynx.

The brain occupies a position about one-fifth the length of the animal from the anterior end of the body. Neither it nor the main nerves are distinct, and accordingly have not been studied to any considerable extent, though sufficiently to decide that all conform to the customary type.

The testes are rather uniformly distributed, and the sperm canals leading from them appear to form an anastomosing system. The vasa deferentia are likewise delicate and somewhat difficult to follow, though their general features appear with considerable distinctness. From the seminal vesicle (Pl. XIII, fig. 8) each swings outward and forward, becoming somewhat anastomosed, and when they have reached points lateral to the uteri and midway between the mouth and the posterior end of the pharynx they turn sharply backward, pass inward toward the mid line and fuse immediately behind the pharynx. The remaining features of the male reproductive system (Pl. XIII, fig. 14) are relatively simple. From the seminal vesicle, which is adjacent to the posterior end of the pharynx, the ejaculatory duct pursues a short and direct course posteriorly to the penis. This last-named organ is enclosed within a spherical, muscular sheath from which a comparatively long, loop-shaped tube leads to the common reproductive pore.

The ovaries are dorsally placed, and their ducts, usually invisible, lead to the uteri which surround the pharynx, since they are anteriorly continuous across the mid line. Skirting the pharyngeal folds, the uteri extend backward (Pl. XIII, fig. 8) and fuse in the mid line, immediately posterior to the penis, to form the egg canal. This median canal is continuous posteriorly with the ample accessory sac (Pl. XIII, fig. 14), and in the opposite direction it enlarges into the thick-walled bursa copulatrix which in turn leads to the common opening.

It is interesting to note in this connection the presence of large quantities of spermatozoa, in two individuals, stored in the accessory gland. That it is not an accidental condition is evidenced by the fact that in many places sperms were attached in dense masses to the epithelial lining. This is the only species in which we have found male reproductive elements in the accessory gland, and accordingly we are not prepared to make any sweeping generalizations, but appearances lead us to the belief that in this species the accessory gland functions, at least in part, as a seminal receptacle.

*Leptoplana maculosa* Stimpson.

Oblong-ovate; above pale gray with a few yellow spots, median spots obscure, margin hyaline. Primary eye clusters in two ovate spots, seven in each; groups placed at the extremities of the hyaline, transverse, arcuate areola. Two small groups of secondary eyes situated before the middle of the areola; secondary eyes four to six, dispersed in the areola between the primary eyes. Length 0.8, breadth 0.4 inch.

In the Bay of San Francisco, along the shore under stones in marshy places. (Free translation.)

Although we have sought for this flatworm in the type locality and in Monterey Bay, we have discovered no specimens that can with certainty be identified as this species.

Genus **PHYLLOPLANA** Laidlaw, 1903.

Leptoplanoid with flattened, leaf-like body. A pair of long muscular vesiculae seminales, which lie parallel to the median ductus ejaculatorius and penis and receive the vasa deferentia of either side, respectively, at their hinder ends.

*Phylloplana litoricola* sp. nov.

This species is represented by nine individuals, living on the under surface of stones below the medium-tide mark along the southern shore of Monterey Bay. It is fairly active and capable of swimming

actively for short distances. Dorsally the color is dark, marbled brownish-gray varying to almost black. A pale yellow streak extends along the median line in the region of the pharynx. This is bordered on each side by a dark, brownish line of similar length, which fades into the ground color. On the ventral surface of the animal pigment is lacking, the tissues appearing clear white and of such thickness that the internal organs are invisible in living material.

The largest specimen is long oval (Pl. XII, fig. 7) in outline and measures 19 mm. in length by 9 mm. in width. The penis is directed backward. Four distinct eye clusters (Pl. XVIII, fig. 42) occur associated with the brain, an elongated pair composed of small eyes on each side of the brain, and a more or less circular pair comprising larger ocelli located slightly behind the level of the brain.

The mouth, approximately central, opens into the much-folded pharynx (Pl. XII, fig. 7) that is nearly half as long as the body. A short distance anterior to the external mouth the inner mouth leads into the spacious and much elongated main gut provided usually with fourteen pairs of variously shaped intestinal branches. These last-named subdivisions branch dichotomously and give no evidence of forming an anastomosing system.

The brain is located about one-sixth of the body length from the anterior end of the animal, but as neither it nor the branches arising from it are distinct, no attempt has been made to study this system in detail.

As usual the testes are ventral and are thickly distributed, especially near the middle of the body. The vasa deferentia form a U-shaped loop (Pl. XII, fig. 7), the bow of which passes immediately behind the female reproductive pore, while anteriorly the two limbs turn sharply inward, and coursing parallel to the outer arms for half their length again bend quickly, and after pursuing an anterior course for a short distance expand to form two seminal vesicles (Pl. XV, fig. 23). These converge into a common duct, the ductus ejaculatorius, that after piercing the granular gland passes into the base of the penis. This latter organ is of the usual type, directed backward and opens to the exterior at a point about one-fifth the body

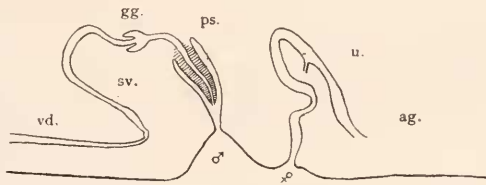


Fig. 4.—Longitudinal section through central reproductive apparatus of *Phylloplana litricola*.

length from the posterior end of the body. There is a fair-sized antrum masculinum.

The ovaries are dorsal and communicate with the uteri by an anastomosing system of connecting tubules. The uteri, fused in the mid line anteriorly (Pl. XII, fig. 7), pass backward, skirting the margin of the pharynx, and then coursing parallel to the vasa deferentia posteriorly meet in the mid line. Here they enter the duct leading forward from the accessory gland (Pl. XV, fig. 23), and on the other hand pursue a somewhat tortuous course to expand into the antrum femininum, that opens to the exterior immediately in front of the posterior loop of the vasa deferentia. About opposite the granular gland of the male system the uteri become distended to form spindle-shaped glands, which may correspond to uterus glands in other species.

Two specimens were kept in captivity for a few days early in June, and deposited several hundred eggs at the average rate of one every forty-five seconds.

#### Tribus COTYLEA.

With sucking disc. Mouth in middle of the body or anterior to it. Copulatory apparatus in the anterior end of the body. Without tentacles or with marginal tentacles.

#### Family PSEUDOCERIDÆ Lang, 1884.

Body oval or elliptical with fold-like marginal tentacles. Mouth in middle of anterior half of body. Pharynx collar-like. Main gut long and spacious. Intestinal branches numerous and anastomosing. Eyes in brain area and tentacles.

#### LICHENIPLANA gen. nov.

Small papillæ on dorsal surface. Gut branches very numerous. Copulatory apparatus single.

#### *Licheniplana lepida* sp. nov.

This species is represented by four individuals collected on the under surface of stones on the southern shore of Monterey Bay. The largest specimen is broad oval in outline (Pl. XIV, fig. 17) and measures 12 mm. in length by 8 mm. in width. It is a very delicate species, living in crevices of the rocks or similar places of concealment, and when disturbed is exceptionally slow in its movements. Dorsally the ground color is white, gray, or lead color with occasional small pinkish or dark red pigment spots. The ventral surface is unpigmented.

The mouth (Pl. XV, fig. 17) is situated between one-fourth and one-fifth of the length of the body from the anterior end. The ventral sucker is placed approximately three-sevenths of the body length from the posterior end. The penis is between one-third and one-fourth of the length of the animal from the anterior margin, immediately behind the pharynx, and is directed forward. Nuchal tentacles are lacking, while the marginal tentacles appear as somewhat thickened flaps. Eyes, indefinitely grouped into two clusters (text fig. 5), occur between the tentacles, while a second pair of about fifteen eyes each and more clearly differentiated occupy the brain area. It is interesting to note that dorsal papillæ (Pl. XIII, fig. 11), of small size but clearly defined, exist in this species, being especially abundant in the anterior part of the body.

The mouth (Pl. XV, fig. 17) opens into the much-folded pharynx which is between one-sixth and one-seventh as long as the body.

Somewhat behind the external mouth the inner mouth leads to the main chamber of the gut, a long and spacious structure provided with approximately fifty pairs of lateral branches. These last-named subdivisions branch frequently and form a highly anastomosing system.

The brain is situated half-way between the anterior end of the body and the mouth, but the nerves to which it gives rise are very indistinct and little attempt has been made for this reason to work out the system in detail.

The testes are ventral and rather uniformly distributed. There is some evidence that these organs are connected by an anastomosing system of sperm capillaries, which eventually fuse to form the vasa deferentia (Pl. XV, fig. 17), relatively large, convoluted canals extending along the margins of the gut throughout most of its length. They arch inward to enter the seminal vesicle (Pl. XVII, fig. 36), almost spherical in form, without the formation of a common



Fig. 5.—Brain and tentacle eyes of *Ticheniplana lepida*.

canal. The ductus leaves the anterior end of the seminal vesicle, bends backward, then sharply downward and forward again to enter the base of the short, conical penis. Near the base of the penis this canal is joined by a very short duct leading from the granular gland, a small oval body that to a certain extent occupies a space between the penis and the seminal vesicle.

The ovaries are dorsal and connect with the uteri by means of ducts that very plainly anastomose. The uteri (Pl. XV, fig. 17) have been traced backward to a point about opposite the end of the main gut and forward to a point opposite the mouth. At the level of the female reproductive pore the uteri converge (Pl. XVII, fig. 36) and unite with a short median canal, the vagina, which leads anteriorly to the exterior at a point immediately posterior to the seminal vesicle.

Family **EURYLEPTIDÆ** Lang, 1884.

Body oval or elliptical, with or without solid marginal tentacles. Mouth near anterior end of body. Pharynx tubular. Main gut, long and narrow. Male apparatus simple. Eyes in brain region and tentacles.

Genus **STYLOSTOMUM** Lang, 1884.

Body smooth. Mouth and male sex pore communicating with a common atrium. Pharynx cylindrical. Gut pouches not anastomosing. Anterior median gut branch lacking in region of pharyngeal pouch. Female sex apparatus ventral to base of pharyngeal pouch. Tentacles very rudimentary.

*Stylostomum lentum* sp. nov.

This species is represented by six individuals taken near Monterey, Calif., at low-tide level. It is a sluggish animal and seemingly incapable of swimming. The ground color of the dorsal surface is orange. A somewhat darker shade occurs along the mid line from the eyes to the posterior end of the mid gut, but laterally this patch becomes lighter and near the margin of the body sends out ray-like expansions that alternate with irregular streaks of bright yellow. Minute white specks are scattered over the entire dorsal surface.

The largest specimen measured 9 mm. in length by 5 mm. in width, and was elliptical in outline (Pl. XIII, fig. 16). The mouth is situated immediately behind the brain about one-tenth of the length of the body from the anterior end and, as in other species of the genus, serves also as the male reproductive opening. The penis is directed forward. Short, blunt, and somewhat rudimentary tentacles (Pl.



XVIII, fig. 40) occur on the anterior margin with a cluster of approximately eighty small eyes at the base of each. The cerebral eyes form two rather long, closely approximated groups, with about fifty medium-sized ocelli in each, located chiefly posterior to the brain.

In the midst of the cerebral groups of eyes the mouth (Pl. XIII, fig. 16) occurs and leads into a long, spacious canal which may be considered as a portion of the pharyngeal cavity. The unfolded pharynx is tubular in form, but anteriorly it tapers to a fairly acute point. In length it equals about one-seventh that of the animal. Posteriorly it opens into a main gut of average size that usually gives rise to four pairs of lateral branches, the most posterior of which is some distance from the hinder end of the gut, thus forming a terminal blind sac. The intestinal branches do not anastomose, nor are the secondary branches numerous.

The brain holds a position one-twelfth the body length from the anterior end of the body, but owing to their indistinctness the course of the nerves, to which it gives rise, has not been determined.

In this species the testes, ventral in position, are clearly defined, but the sperm canals are totally invisible. The vasa deferentia are likewise somewhat ill-defined, but may be seen (Pl. XIII, fig. 16) in favorable specimens to arise about opposite the posterior end of the pharyngeal chamber and to extend anteriorly to a point not far behind the level of the mouth. Here they turn abruptly backward and inward to enter the seminal vesicle (Pl. XVII, fig. 37) at its antero-ventral extremity. The seminal vesicle is more or less heart-shaped, and is placed immediately in front of the pharynx and ventral to the tube leading from the pharyngeal cavity to the external mouth. Leaving the seminal vesicle anteriorly, the ejaculatory duct makes its way to the base of the penis where it receives a short duct from the granular gland. This last-named organ is small, spherical, and is located immediately in front of the seminal vesicle. The penis is very short, in some specimens rather abruptly pointed, and it opens into a chamber contained within the penis sheath, which in turn opens into the antrum masculinum. This last-named space communicates with the mouth.

The ovaries contain, during the breeding season, an unusually large number of ova and are accordingly very distinct, though the ducts connecting them with the uteri are invisible except occasionally in sections. The uteri (Pl. XIII, fig. 16) originate approximately half the distance from the ventral sucker to the posterior end of the main gut. From this point, where apparently they do not fuse

across the mid line, they extend forward skirting the gut as unbranched, swollen chambers often filled with a comparatively large number of ova. Opposite the posterior end of the pharyngeal pocket they bend inward and unite under the base of the pharynx. The resulting median duct is short and proceeds anteriorly and ventrally to the ample shell chamber which receives the ductules from many filiform glands (Pl. XVIII, fig. 37). Ventral to this point is the moderate antrum which opens to the exterior ventral to the base of the pharynx. Dorsal to the shell chamber a small zone of glandular tissue, staining darkly in Delafield's hæmatoxylin, surrounds the egg canal. What its function is it is impossible to determine. No uterus glands were observed in any of the whole mounts or sections, though considerable pains were taken to determine this point.

Genus **ACEROS** Long, 1884.

Body smooth. Mouth immediately behind the brain. Pharynx cylindrical. About 5 pairs of gut branches. Male sex pore immediately behind the mouth; female near hinder end of pharyngeal pouch. Tentacles lacking.

*Aceros langi* sp. nov.

A single representative of this species was taken on the southern shore of Monterey Bay, but concerning its habits or habitat we are without information. Its form in life was probably elliptical and measures 8 mm. in length by 6 in width. The ventral sucker (Pl. XII, fig. 5) is slightly posterior to the middle of the body. The anterior margin of the animal was slightly injured which prevents the precise determination of the exact location of the mouth with

reference to it. However, the mouth may safely be said to be very close to the anterior end of the body. The penis is directed forward. There are no nuchal tentacles; marginal tentacles may have existed on the damaged portion, though no trace of them now remains. About fifty large eyes (text fig. 6) overlie the brain area that are roughly divided into two irregular clusters. No eyes have been seen on other regions of the body.

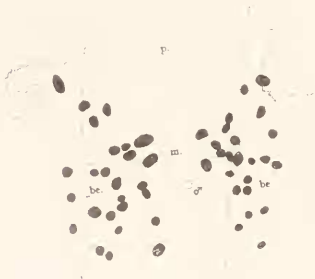


Fig. 6.—Eyes of *Aceros langi*.

The mouth (Pl. XVII, fig. 38) opens into the cylindrical pharynx-

geal pocket, which in the present instance contains a long and slender proboscis, protruded a short distance beyond the mouth opening. Posteriorly the pharynx leads into the capacious main gut which gives rise to five pairs of lateral intestinal branches together with an anterior terminal one. At the outset all of these branches are comparatively large and of fairly even caliber, but they soon become transformed into a branching, non-anastomosing system of rather narrow twigs. The sucker underlies the gut between the fourth and fifth pairs of lateral branches. Beyond the last pair the gut extends posteriorly to a point close to the posterior end of the body.

The brain is situated directly over the mouth, but as the nerves arising from it are seen with much difficulty, no serious attempt has been made to determine their distribution.

The testes are rather uniformly distributed ventrally, but the capillaries leading from them are invisible in the present specimen. The vasa deferentia (Pl. XII, fig. 5) arise at the end of the first body third, midway between the gut and the margin of the body, and converge anteriorly as simple though much swollen and convoluted ducts. Opposite the middle of the pharyngeal pocket they pass inward toward the mid line to fuse mesally at the point where the oval seminal vesicle is located. From this last-named organ a short ejaculatory duct extends anteriorly to the penis situated immediately behind the mouth. The male reproductive pore could not be determined with absolute certainty. Certain features suggest that it opens into the mouth, and on the other hand there are faint indications that it is situated immediately behind the mouth, yet independent of it. A granular gland was not distinguished.

The ovaries are dorsal. The uteri (Pl. XVII, fig. 38), originating at the level of the sucker, are so greatly inflated by multitudes of eggs that they exceed the main gut in caliber. Between the second and third pairs of gut branches the uteri fuse and send forward a short, slender duct, the vagina, which communicates with the exterior close to the posterior end of the pharyngeal pocket.

Contrary to the rule, no uterus glands could be detected where, according to Lang, one pair should exist.

**ANCILIPLANA** gen. nov.

Body broadly elliptical. Tentacles large, without eyes; cerebral eyes in two distinct groups. Pharynx small; main gut slender with 8 pairs of branches, highly anastomosed. Vasa deferentia and uteri anastomosed. No uterus glands.

*Anciliplana graffi* sp. nov.

Several specimens of this species were collected in Monterey Bay and along the adjoining coast. The largest specimen is broad oval in outline and measures 18 mm. in length by 13 in greatest width. No color notes were obtained. The ventral sucker is slightly anterior to the middle of the body. The mouth is placed one-sixth the length

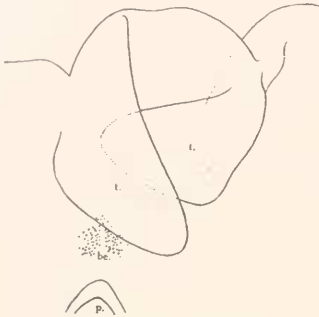


Fig. 7.—Eyes and tentacles of *Anciliplana graffi*.

of the animal from the anterior margin. The penis is directed forward. The tentacles are large, broadly triangular outgrowths of the anterior margin of the body extending posterior to the brain. Small eyes (text fig. 7) occur above the brain in two imperfectly separated groups. No eyes occur on or about the tentacles.

The pharynx (Pl. XVII, fig. 35), more or less conical in form, leads into the main gut which communicates in turn with an average of eight pairs of

intestinal branches. These plainly anastomose at the outset and probably continue to do so even to the margins of the body.

The brain is located immediately in front of the pharyngeal pocket, but other details of the nervous system have not been determined. The testes are ventrally disposed, and clearly defined sperm capillaries are totally invisible in cleared specimens. The vasa deferentia (Pl. XVII, fig. 35) first appear opposite a point slightly behind the sucker. Their many ramifications finally converge anteriorly to form the large single ducts (Pl. XVI, fig. 31) which bend sharply backward behind the penis and curve inward to form a semicircular transverse canal. From the centre of this arch a very short duct pursues a direct course to the large and spherical seminal vesicle. The ejaculatory duct leaves the vesicle at the opposite side and soon enters the base of the penis. The granular gland, communicating with this canal at the base of the penis, is elliptical in outline and lies between the penis and the seminal vesicle.

The ovaries are dorsal and the uteri, which plainly anastomose (Pl. XVII, fig. 35) from the first, probably connect with the former by means of a system of anastomosing capillaries. The web-like uteri extend lateral to the main gut throughout the greater part of its course, and posterior to the seminal vesicle converge (Pl. XVI,

fig. 31) to form the single short, female duct, the vagina, which opens to the exterior immediately behind the arc of the vasa deferentia.

Genus **EURYLEPTA** Ehrenberg, 1831.

Pharynx cylindrical, about 5 pairs of intestinal branches without anastomoses. Male sex opening beneath base of pharynx.

*Eurylepta aurantiaca* sp. nov.

This species is fairly common in Monterey Bay and the neighboring coast where it occurs under stones or crawling along the bottom in comparatively shallow water. It is sluggish in its movements and clings most tenaciously when an attempt is made to remove it. The largest specimen is broadly oval in outline (Pl. XIV, fig. 18) and measures 15 mm. in length by 10 mm. greatest diameter. Generally speaking, the color of the dorsal surface is yellowish-pink or salmon tint except along the mid line where a bright pink streak extends from the eyes to the posterior end of the main gut. Minute white specks are uniformly distributed over the entire dorsal surface. On the ventral side of the animal pigment is lacking, and the opaque, white somatic muscles are of such thickness that they wholly obscure all of the internal organs.

The ventral sucker is slightly behind the middle of the body. The mouth (Pl. XIV, fig. 18) is placed somewhat less than one-sixth the length of the body from the anterior margin of the body. The penis is directed forward. Nuchal tentacles are lacking, and the marginal tentacles (text fig. 8) are rather short, stout outgrowths that, when the animal is at rest, are folded back on the dorsal surface. Numerous eyes are distributed on the tentacles in two distinct clusters with approximately 70 eyes in each, while two fairly well-defined oval groups, each with about 50 ocelli, occur dorsal to the brain.

The mouth (Pl. XIV, fig. 18) opens into a spacious pharynx, appearing like an inverted shield in outline, with a length equalling one-sixth that of the body.

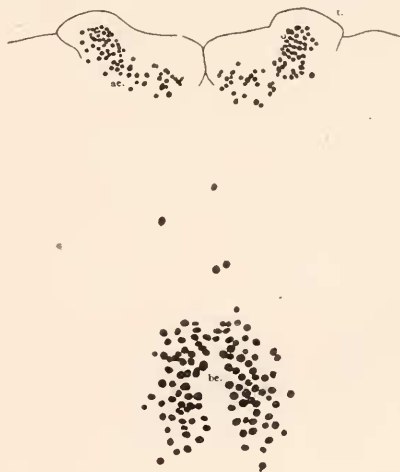


Fig. 8.—Eyes of *Eurylepta aurantiaca*.

Posteriorly the pharyngeal cavity communicates with the spacious chamber of the main gut which extends backward close to the posterior end of the animal, giving rise to seven or eight pairs of intestinal branches during its course. These last-named structures are at first of even caliber, but soon become swollen and greatly constricted, giving the impression of a dichotomously arranged system of large spherical vesicles.

The brain is situated immediately in front of the pharynx, but otherwise the details of the nervous system have not been determined clearly.

The testes are ventral and in some cases are united by anastomosing sperm capillaries (Pl. XIV, fig. 18) that, on the other hand, unite with the vasa deferentia. The latter originate at the level of the sucker, and, pursuing a tortuous course as they proceed anteriorly, they finally swing inward at a point not far behind the pharyngeal pocket. Here they unite (Pl. XVII, fig. 34) and as single tube proceed anteriorly into the base of the penis. At the same point where the penis receives this median duct it also communicates with the outlet of the ample and elliptical granular gland. There is no seminal vesicle. The penis is moderately thin walled and inflated and is guarded by a closely enveloping sheath which in turn lies at the base of an antrum masculinum of average proportions.

The ovaries are dorsal and in some specimens are clearly united by a system of capillaries that unite with the uteri close to the outlet of the so-called uterus glands. In a general way the uteri (Pl. XIV, fig. 18) may be said to arise midway between the sucker and the posterior end of the gut, and from this point to extend forward, anastomosing somewhat, to turn sharply inward opposite a point midway between the sucker and the anterior gut-end. Here they fuse (Pl. XVII, fig. 34) into a median duct, the vagina, that leads to a small antrum femininum and to the exterior immediately behind the point of fusion of the vasa deferentia. In the location where each uterus commences to swing in toward the mid line, it is joined by a short duct leading from a well-developed uterus gland of varying size according to the proximity of the breeding season. They may be almost spherical or contracted into a thin crescent or, as appears to be a more usual state, elliptical. The duct leading from it arises from the inner surface of the gland.

**EURYLEPTODES** gen. nov.

Pharynx relatively small; main gut slender with 7 to 8 anastomosing



branches. Male sex pore at base of penis. Vas deferens simple or anastomosed; uterus anastomosing; no uterus glands.

*Euryleptodes cavicola* sp. nov.

Nine specimens represent this species taken at various points along the shores of Monterey Bay. It occurs, at moderately low-tide mark, on the under surface of loose boulders or concealed in crevices of the bottom rock or among the holdfasts of seaweeds. Its movements are generally slow and deliberate, never sufficiently vigorous to enable the animal to swim. The texture of the body is very delicate, and three of the specimens show extensive signs of partially regenerated injuries.

The color of the dorsal surface is greenish-white, irregularly marked with small, round white spots and dark red lines of varying length and direction. As a general thing, there are five fairly well-defined transverse lines, the first of which is immediately behind the tentacles and the last not far from the posterior end. Two irregular longitudinal stripes, at times ill-defined, commence at the first transverse line at points midway between the edges of the body and the median line and extend backward to the last transverse line. The ventral surface of the body is unpigmented.

The largest specimen is broadly oval (Pl. XVI, fig. 29) and measures 31 mm. in length by 20 mm. in greatest width. The ventral sucker is almost exactly in the centre of the body. The mouth is located about one-sixth the length of the animal from the anterior end. The penis is directed forward. Nuchal tentacles are wanting, but the marginal tentacles (text fig. 9) are very large, fleshy outgrowths of the anterior body edge. Numerous small eyes are scattered over the tentacles and even between them; and a group of somewhat larger eyes, divisible into two closely approximated clusters of about seventy each, overlies the brain.

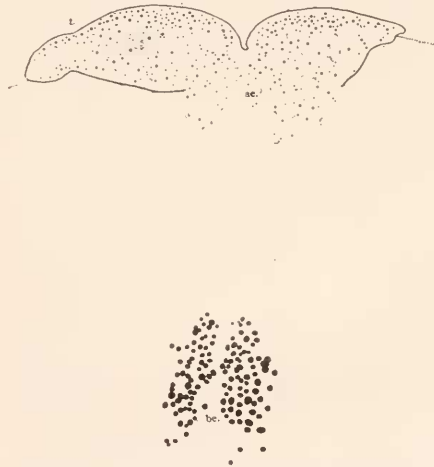


Fig. 9.—Eyes of *Euryleptodes cavicola*.

No especially noteworthy features have been noted in connection with the digestive system. The mouth (Pl. XVI, fig. 29) opens into the acorn-shaped pharynx which has a length equal to about one-ninth that of the body. Posteriorly it leads into the main gut chamber which originates seven pairs of lateral intestinal branches as a general thing. These are of rather even caliber at their source, but soon become deeply constricted and give rise to a distinct anastomosing system.

The brain is located considerably nearer the mouth than the anterior body margin. Both it and the nerves to which it gives rise are fairly distinct, but in their distribution conform closely to the well-known polyclad type.

The testes are ventral, of moderate size and are clearly united by means of a system of sperm capillaries, that apparently do not anastomose, though this is not definitely established. The vasa deferentia (Pl. XVI, fig. 29) arise close to the posterior end of the gut and skirt the external borders of the uteri. Near the anterior end of the uteri these canals swing abruptly inward and fuse to form a very short, median duct (Pl. XV, fig. 28) which at once enters the large spherical seminal vesicle. Leaving this last-named organ at its opposite end, the slender ductus ejaculatorius passes into the base of the penis. At the point where the latter receives the ductus the rather large, oval granular gland makes its connection. In the clearest of the total mounts the penis and its ducts appeared to arch backward and the male aperture was accordingly posterior to it, though this may have been due to contractions due to the killing fluids. The penis and male pore are placed about one-fourth of the length of the animal from the anterior margin of the body. There is an antrum masculinum of average size.

The ovaries are dorsal and are united by an anastomosing system of canals with the uteri. These last-named organs meet in the mid line directly behind the mid gut (Pl. XVI, fig. 29), though they apparently do not fuse. Extending forward outside of the borders of the gut they anastomose frequently, particularly near the anterior end where several convergent branches fuse (Pl. XV, fig. 28) to form the short vagina. This latter organ passes anteriorly a very short distance and opens to the exterior immediately behind the seminal vesicle.

*Euryleptodes pannulus* sp. nov.

But one specimen of this species has ever been seen by us. It was brought into the laboratory together with a large number of other

shore invertebrates, and we could obtain no data regarding its habitat; and as it came into our hands in a preserved state, no color notes are available. The body is broadly elliptical in outline and measures 12 mm. in length by 8 in width. The mouth is placed about one-fifth the length of the body from the anterior margin. The penis is directed forward. The tentacles are lacking or are exceedingly rudimentary,<sup>2</sup> and in the position usually occupied by marginal tentacles numerous eyes appear to be the only well-defined sense organs. Other eyes, of somewhat larger size, also occur over the brain in two narrow, closely approximated clusters. Together these are no wider than the brain, though they are considerably longer.

The mouth is situated in the anterior fifth of the animal and opens into a cylindrical pharynx, whose length is slightly less than one-sixth that of the animal. Posteriorly the pharynx leads into the main gut chamber, of rather slender outline and with seven or eight pairs of lateral intestinal branches. These distinctly anastomose from the first.

The brain is situated half-way between the mouth and the anterior body margin, but the imperfect preservation of the animal renders it impossible to trace even the main nerves.

The testes are ventral and the ducts from them may possibly form an anastomosing system, though this is far from being proved. The large vasa deferentia, originating opposite a point be-



Fig. 10.—Ventral view of *Euryleptodes pannulus*.



Fig. 11.—Central reproductive apparatus of *Euryleptodes pannulus*.

<sup>2</sup> It is possible that the peculiar shape of the tentacle region may be due to injury and partial regeneration.

tween the sucker and the posterior end of the gut, proceed anteriorly and after skirting the uteri sweep inward to fuse in the mid line. The canal thus formed immediately plunges through the spherical seminal vesicle and as a slender ejaculatory duct directs its course to the penis. The granular gland is oval, of moderate size, and opens into the ejaculatory duct near the penis.

The ovaries are dorsal. The uteri extend posteriorly to the same distance as the main gut, behind which they fuse to form a short median branch. Anteriorly they extend between the gut and the vasa deferentia, and converge to open in the mid line a short distance posterior to the seminal vesicle.

*Euryleptodes phyllulus* sp. nov.

This species is represented by several individuals taken on the southern shore of Monterey Bay. The largest specimen is elliptical in outline (Pl. XVI, fig. 33) and measures 28 mm. in length by 18 mm. in width. Color notes are wanting. The sucker is slightly anterior to the centre of the body. The mouth is about one-eighth the length of the body from the anterior end near the apex of the pharyngeal pocket. The penis is directed forward. The tentacles (Pl. XVI, fig. 33) are fleshy outgrowths of the anterior margin of the body, extending posteriorly as far as the brain. On and between the tentacles are medium-sized eyes (text fig. 12) which assume no definite arrangement, and they also occur over the brain in a triangular group, of about 150 ocelli, which are faintly divisible into two clusters.



Fig. 12.—Eyes of *Euryleptodes phyllulus*.

The mouth (Pl. XVI, fig. 33) opens into the roughly triangular-shaped pharynx from which the main gut proceeds posteriorly, giving rise to about seven pairs of intestinal branches. These last-named organs are often swollen at their bases, but more distally gradually decrease in caliber and form an elaborately anastomosing system.

The brain is situated immediately in front of the pharyngeal pocket, but the other details of the nervous system are well-nigh invisible in surface mounts.

The testes (Pl. XVI, fig. 33) are liberally distributed over the ventral half of the animal, but no trace has been seen of the connecting sperm capillaries. The vasa deferentia extend posteriorly

as far as a point midway between the sucker and the posterior end of the gut and laterally half-way to the margin of the body. Not far behind the pharyngeal pocket the meshes of the vasa deferentia converge (Pl. XV, fig. 25) to form a pair of ducts which pass abruptly inward to enter the seminal vesicle from the rear. This last organ is large, oval, and the ejaculatory duct leaving its anterior border passes quickly to the base of the penis, communicating with the exterior immediately below the posterior margin of the pharyngeal sheath.

The ovaries (Pl. XVI, fig. 33) are dorsal, but the ducts connecting them are invisible in total mounts. The uteri, on the other hand, are clearly defined and fuse behind the posterior end of the gut, forming a short median canal. From this point they extend anteriorly on either side of the main gut for nearly its entire length and open to the exterior immediately below the posterior end of the seminal vesicle. Numerous radiating ductules (Pl. XV, fig. 25) from the shell gland centre in the neighborhood of the vagina.

#### BIBLIOGRAPHY.

- HEATH, H.: The Anatomy of *Epibdella squamula*, *Proc. Cal. Acad. Nat. Sci.*, Vol. 3, 1902.  
 — A New Turbellarian from Hawaii, *Proc. Acad. Nat. Sci. Philadelphia*, 1907.  
 LAIDLAW, F. F.: On the Marine Fauna of Zanzibar and British East Africa, *Proc. Zool. Soc. London*, Vol. 2, 1903.  
 LANG, A.: Fauna und Flora des Golfes von Neapel, Vol. II, Die Polycladen.  
 PLEHN, M.: Neue Polycladen, *Jena. Zeit. f. Naturw.*, Bd. 30, 1895.  
 — Drei neue Polycladen, *Ibid.*, Bd. 31, 1898.  
 STIMPSON, W.: Prodromus descriptionis animalium evertibratorum, etc., *Proc. Acad. Nat. Sci. Philadelphia*, 1857.

#### EXPLANATION OF ABBREVIATIONS USED IN FIGURES.

ab.....anterior intestinal branch.	od.....oviduct.
ae.....marginal eyes.	os ..... ovaries.
af.....antrum-femininum.	p ..... pharynx.
ag.....accessory gland.	pp ..... pharyngeal pocket.
ai.....intestinal anastomoses.	ps ..... penis.
am.....antrum-masculinum.	pss.....penis sheath.
b.....brain.	pt.....dorsal pits.
bc.....bursa copulatrix.	sa.....pouch of antrum-masculinum.
be.....brain (or cerebral) eyes.	sc.....shell chamber.
dp.....dorsal pits.	sg ..... shell glands.
ed.....ejaculatory duct.	sv.....seminal vesicle.
gg.....granular-gland.	t ..... marginal tentacles.
gs.....gland-like structures.	te.....nuchal tentacle eyes.
ib.....lateral intestinal branches.	ts.....testes.
in.....inner mouth.	u ..... uterus.
m.....mouth.	ug.....uterus-gland.
mg ..... mid-gut.	v. .... vagina.
nt.....nuchal tentacles.	vd.....vas deferens.
o.....ova.	vs.....ventral sucking disk



## EXPLANATION OF PLATES XII-XVIII.

All of the figures were drawn by E. A. McGregor.

PLATE XII.—Fig. 1.—*Leptoplana timida*, ventral view.

Fig. 2.—*Stylochoplana gracilis*, ventral view.

Fig. 3.—*Leptoplana rupicola*, ventral view.

Fig. 4.—*Leptoplana saxicola*, ventral view.

Fig. 5.—*Aceros langi*, ventral view.

Fig. 6.—Reproductive apparatus of *Stylochoplana gracilis*.

Fig. 7.—*Phylloplana litoricola*, ventral view.

PLATE XIII.—Fig. 8.—*Leptoplana inquieta*, ventral view.

Fig. 9.—Tentacle and cephalic eyes of *Planocera burchami*.

Fig. 10.—Penis of *Leptoplana rupicola*.

Fig. 11.—Section through dorsal papilla of *Licheniplana lepida*.

Fig. 12.—Central reproductive apparatus of *Leptoplana timida*.

Fig. 13.—Penis, granular gland and seminal vesicle of *Leptoplana rupicola*.

Fig. 14.—Central reproductive apparatus of *Leptoplana inquieta*.

Fig. 15.—Portion of male reproductive apparatus of *Leptoplana rupicola*.

Fig. 16.—*Stylostomum lentum*, ventral view.

PLATE XIV.—Fig. 17.—*Licheniplana lepida*, ventral view.

Fig. 18.—*Eurylepta aurantiaca*, ventral view.

Fig. 19.—Brain and eyes of *Leptoplana saxicola*.

Fig. 20.—Brain, tentacles and eyes of *Stylochoplana gracilis*.

Fig. 21.—Dorsal and ventral nervous systems of *Leptoplana saxicola*.

PLATE XV.—Fig. 22.—Central reproductive apparatus of *Leptoplana rupicola*.

Fig. 23.—Same of *Phylloplana litoricola*.

Fig. 24.—Same of *Planocera californica*.

Fig. 25.—Same of *Euryleptodes phyllulus*.

Fig. 26.—Longitudinal vertical section through central reproductive apparatus of *Stylochoplana gracilis*.

Fig. 27.—*Planocera burchami*, ventral view.

Fig. 28.—Reproductive apparatus of *Euryleptodes cavicola*.

PLATE XVI.—Fig. 29.—*Euryleptodes cavicola*, ventral view.

Fig. 30.—Central reproductive apparatus of *Leptoplana saxicola*.

Fig. 31.—Same of *Anciliplana graffi*.

Fig. 32.—Vertical longitudinal section through penis of *Planocera californica*.

Fig. 33.—*Euryleptodes cavicola*, dorsal view.

PLATE XVII.—Fig. 34.—Central reproductive apparatus of *Eurylepta aurantiaca*.

Fig. 35.—*Anciliplana graffi*, ventral view.

Fig. 36.—Central reproductive apparatus of *Licheniplana lepida*.

Fig. 37.—Longitudinal section through reproductive apparatus of *Stylostomum lentum*.

Fig. 38.—Central reproductive apparatus of *Aceros langi*.

PLATE XVIII.—Fig. 39.—*Planocera californica*, ventral view.

Fig. 40.—Eyes of *Stylostomum lentum*.

Fig. 41.—Section through eyes and nuchal tentacles of *Planocera californica*.

Fig. 42.—Tentacle and cephalic eyes of *Phylloplana litoricola*.

Fig. 43.—Eyes of *Leptoplana inquieta*.

Fig. 44.—Central reproductive apparatus of *Planocera burchami*, immature individual.